(12) UK Patent Application (19) GB (11) 2 234 354 (13) A

(43) Date of A publication 30.01.1991

(21) Application No 8915399.3

(22) Date of filing 05.07.1989

(71) Applicant
The Marconi Company Limited

(Incorporated in the United Kingdom)

The Grove, Warren Lane, Stanmore, HA7 4LY, United Kingdom

(72) Inventor
Raymond David King

(74) Agent and/or Address for Service
J Waters
The General Electric Company plc, Central Patent Dept, Marconi Research Centre, West Hanningfield Road, Great Baddow, Chelmsford, Essex, CM2 8HN, United Kingdom

(51) INT CL[4]
G01R 29/08, H04B 7/26

(52) UK CL (Edition K)
G1U UR2908
U1S S2204

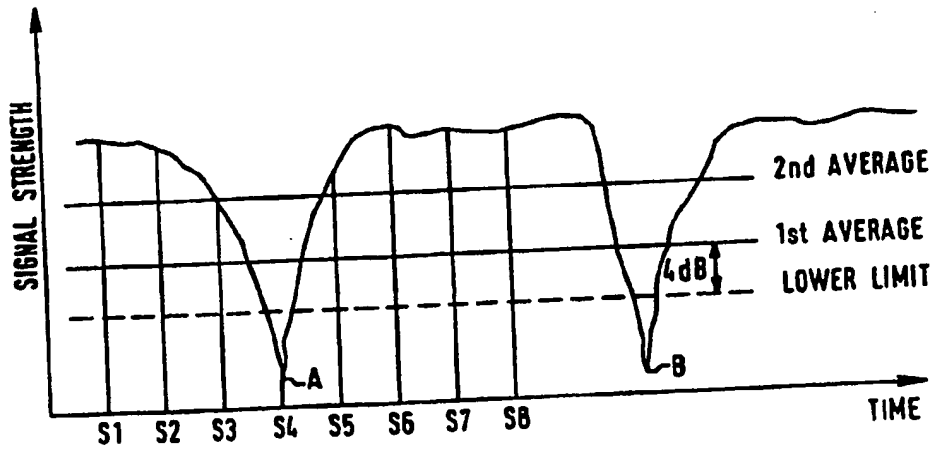
(56) Documents cited
None

(58) Field of search
UK CL (Edition J) G1U UBV14C UBV3, G4A ACX, H3H, H4L
INT CL[4] G01R 19/00 29/08, H04B 7/00

(54) Radio field strength determination

(57) To determine radio field strength using a mobile station at which fade outs such as at A and B, may happen due to multi-path interference, the signal strength is measured by obtaining samples S1, S2 etc, these values are used to obtain a first average value, a lower limit a pre-determined signal strength below the first average value is then defined and then a second average value is obtained by replacing the samples below the lower limit by the value of the lower limit itself. The second average is more representative of signal strength.

FIG .1.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

GB 2 234 354 A

FIG.1.

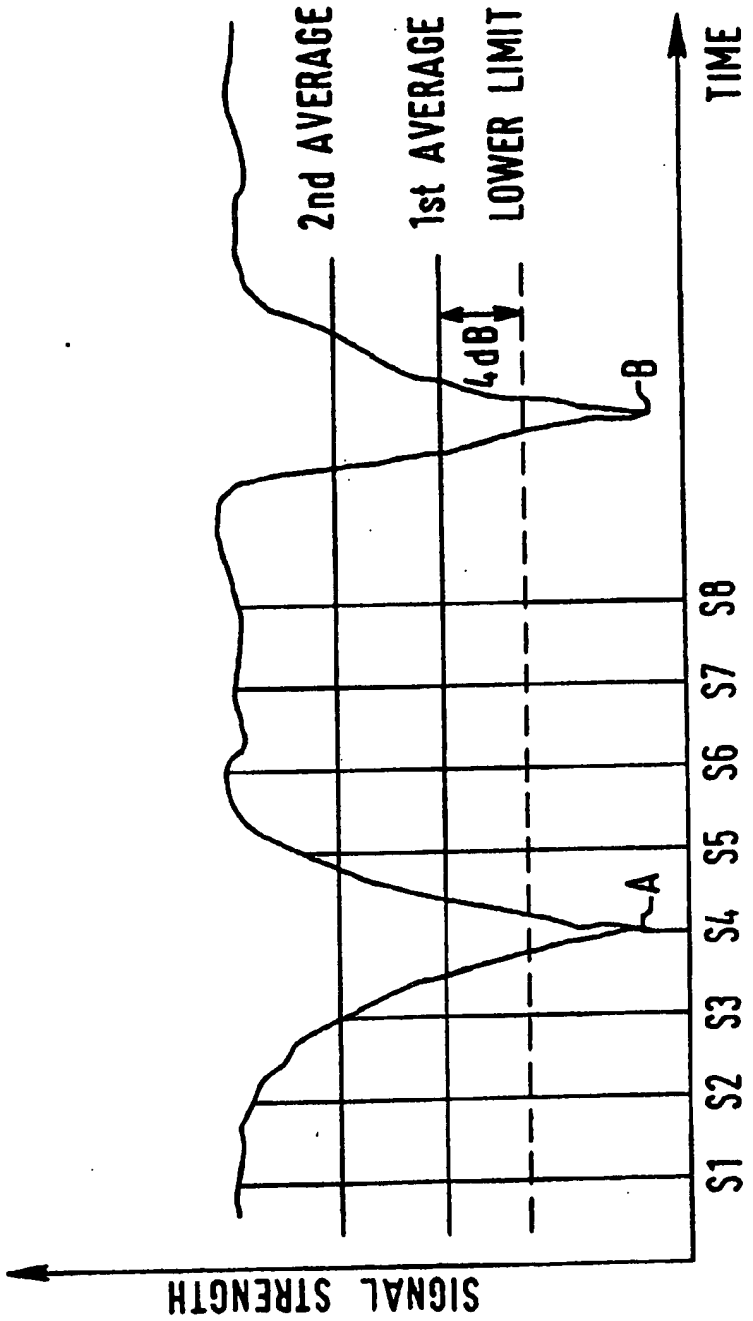

2nd AVERAGE
1st AVERAGE
LOWER LIMIT
4dB
B
A
TIME
S1 S2 S3 S4 S5 S6 S7 S8
SIGNAL STRENGTH

FIG.2.

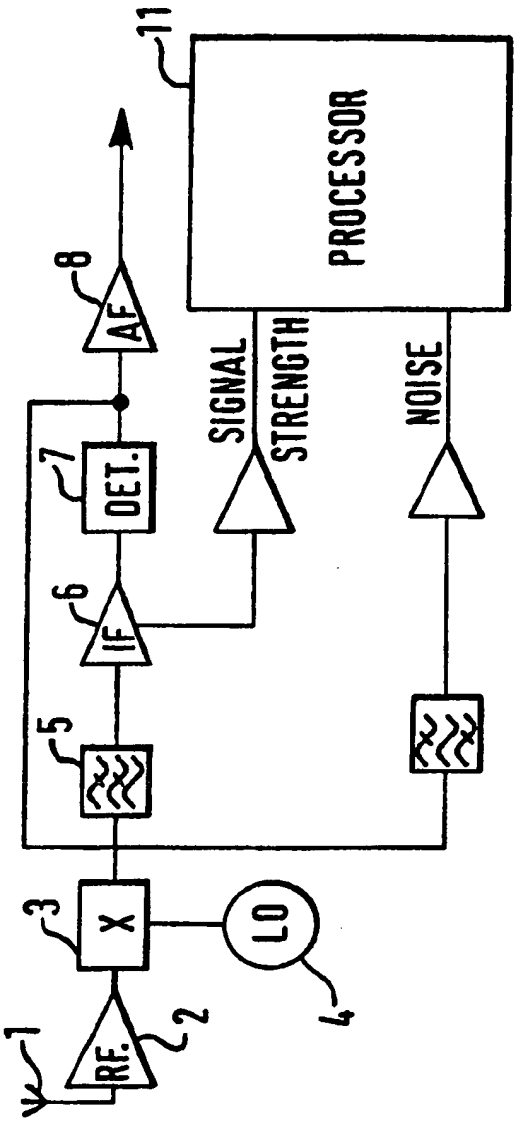
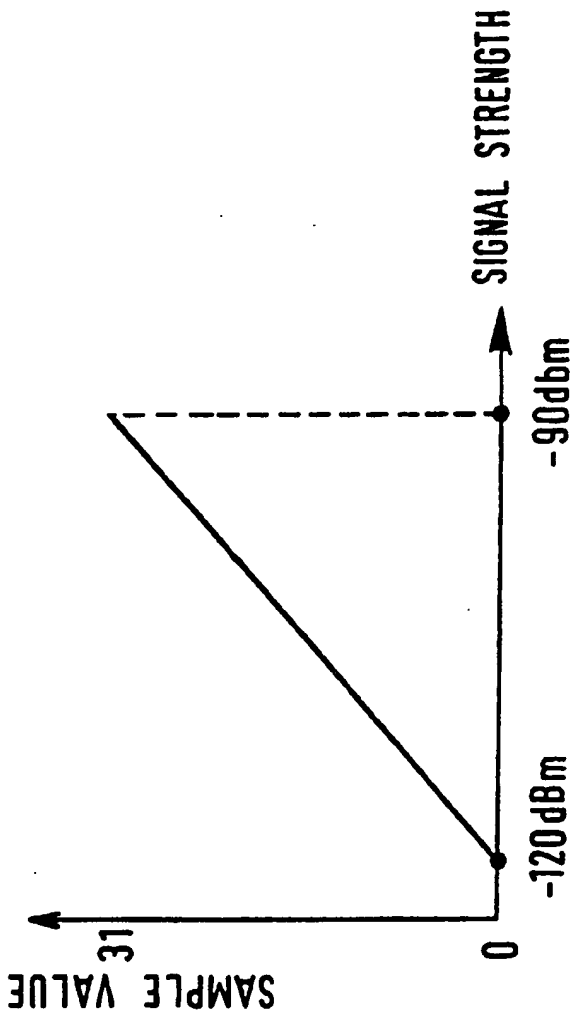

11
PROCESSOR
8
AF
7
DET.
6
IF
5
3
X
LO
4
2
RF.
1
SIGNAL STRENGTH
NOISE

FIG.3.


SIGNAL STRENGTH
-90dBm
-120dBm
0
31
SAMPLE VALUE

2234354

RADIO COMMUNICATION APPARATUS

This invention relates to radio communication apparatus, and especially such apparatus including a mobile station for use with at least one base station.

For efficient operation in trunked mobile radio communication apparatus, it is necessary for the mobile to know the strength of received signals. The control channel which the mobile is receiving from a base station may become unusable and, to receive another one, the mobile may have to scan a large number of other control channels (transmitted from other base stations or from the same base station). This needs to be carried out as quickly as possible, but a problem arises if the mobile is in an environment where multi paths reflections from buildings instantaneously reduce to a large extent the signal strength (this is known as a Rayleigh fading environment).

If the signal strength is measured for a brief period which includes a rapid fade in signal strength, the minimum in signal strength may be such that the average signal strength measurement over that period is deemed too low to be usable. Nevertheless, apart from the rapid fade - and such rapid fades can be very deep reductions in signal strength - the average signal strength may be

usable for communication on a signal channel when such a channel is allocated: If the base station happened to transmit information to the mobile just at the instant of the fade when it might not be received, in many situations the information would simply be re-transmitted after a short interval.

The invention provides radio communication apparatus comprising a mobile station for communication with at least one base station, means for obtaining samples representative of the strength of the signal received at the mobile station on a channel transmitted by the base station, and processing means arranged to produce a 1st average value of signal strength from a pre-determined number of samples, to define a lower limit a pre-determined signal strength below the average, and to produce a 2nd average value of signal strength from the samples but without using any of the values that were below the lower limit.

The omission of values below the lower limit in the calculation of the second average results in a more realistic assessment of signal strength for the short measuring period available.

Radio communication apparatus comprising a mobile station for communication with at least one base station

will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a graph of typical signal strength variation with time;

Figure 2 is a diagram of part of the circuit of the mobile station;

Figure 3 is a graph indicating the relation between the signal strength and the sample values.

The mobile station is designed to communicate with several base stations in the usual way. The mobile communicates with each base station on several channel pairs, each consisting of an up-link and down-link, most of the channel pairs being for communication traffic, but one pair being for control purposes.

This invention is concerned with measurement of signal strength at the mobile of the communication channels of various base stations. In the event that the signal strength becomes unusable, the mobile communicates briefly with other communication channels in an order pre-determined by an algorithm.

When a channel is found which has an adequate signal

lower limit L are now replaced by values equal to the lower limit L. The average of the original samples together with those replaced by the lower limit value is now calculated (2ND AVERAGE).

It is found that the 2nd average is more useful as regards assessing signal strength than the 1st average value, in that the 1st average could be regarded too low to be usable whereas the 2nd, higher average may well not be.

As an example, the 1st average maybe of 8 samples, taken at intervals 3.75 milliseconds, the lower limit maybe 4db down on the first average. Naturally other numbers, samples, intervals or values of the lower limit relative to the first average maybe used.

The relevant parts of a circuit in a mobile to acomplish the above is illustrated in figure 2. The mobile receives signals by an antenna 1, and an r.f. amplifier 2 feeds signals to a mixer 3 feed from a local oscillator 4, and the resulting i.f. signals are band pass filtered by filter 5 and amplified i.f. amplifier 6. The audio signal is recovered by a detector 7, and amplified by an audio frequency amplifier 8.

The samples are based on both the r.f. signal

strength, the mobile now communicates with that channel.

Because the mobile is typically moving, the signal strength of a received channel varies with time. Often, the mobile will be in a vehicle moving in an urban environment between tall buildings. The mobile then receives the direct signal from the base station and/or reflected signals from various buildings. This so-called multi-path effect results brief but pronounced fades in signal strength e.g. at points, A,B.

While the signal strength at point A, B is too low to be usable, nevertheless this does not prevent the channel being usable as a control channel or for traffic purposes since apart from the very brief points A,B, the signal strength is sufficient. However, unless a long time average of the signal strength is made, a time average including the point A could well indicate that the channel is not usable.

In accordance with the invention, the pre-determined number of samples S1, S2 etc representative of the signal strength are obtained over a pre-determined period. The average (1ST AVERAGE) of the sample values is then calculated. Next a lower limit (L) is calculated which is a pre-determined signal strength below the calculated average (1ST AVERAGE). All of the samples lying below the

strength and on the noise of the signal in order that an assessment can still be made of signal strength even when, as at low signal strength, the noise predominates over the signal itself. This is known in itself. The noise signal is tapped from the output of the detector, and passes through a band pass filter 10, which passes 9kHz.

The r.f. signal is tapped from i.f. amplifier 6. Both signals are amplified and passed to processor 11.

The i.f. and noise signals are converted to digital form by an analogue to digital convertor. Each pair of digital values, representing i.f. and noise signals at a particular sampling instant, are fed to a look-uptable and a number between 0 and 31 is obtained representing signal strength.

The characterstic of the values of the samples related to r.f. signal strength as shown in figure 3. The values -90dBm and -120dBm indicate signal strengths as 90db down and 120db down on 1 milliwatt, respectively.

When the signal strength assessment is being performed, 8 sucessive sample numbers are obtained, and the processor calculates the average. The processor then calculates the nearest number (or the next number below) which would correspond to 4db below the average, and the

average is then re-calculated to obtain the 2nd average and hence a better assessment of signal strength.

The signal assessment method need not be used only when the signal becomes unusable. If it is desired to obtain repeated updates on signal strength, the method can be performed repeatedly.

CLAIMS

1. Radio communication apparatus comprising a mobile station for communication with at least one base station, means for obtaining samples representative of the strength of signal received at the mobile station on a channel transmitted by the base station, and processing means arranged to produce a 1st average value of signal strength from a pre-determined number of samples, to define a lower limit a pre-determined signal strength below the average, and produce a 2nd average value of signal strength from the samples but without using any of the values that were below the lower limit.

2. Radio communication apparatus as claimed in claim 1, in which the processing means is arranged to produce the 2nd average value using the samples but with any below the lower limit being replaced by that lower limit.

3. Radio comunication apparatus as claimed in claim 1 or claim 2, in which samples representative of the strength of the signal are in use calculated from values representative of the signal strength and the noise.

4. Radio communication apparatus as claimed in claim 3, in which the processing means include a look-uptable from which samples maybe obtained based on simultaneous samples of signal strength and of noise.

5. Radio communication apparatus substantially as herein before described with reference to the accompaning drawings.

6. A method of measuring signal strength at a mobile station that is suitable for communication with at least one base station, comprising obtaining samples representative of the strength of the signal, producing a first average value of signal strength from a pre-determined number of samples, defining a lower limit a pre-determined signal strength below the average, and producing a 2nd average value of signal strength from the samples but without using any of the values that were below the lower limit.

7. A method substantially as herein before described with reference to the accompanying drawings.

Published 1991 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.